Application of Observations from the COVE Sea Platform, to Determine an Accurate Shortwave Budget for the

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1. Wanted: An Accurate Ocean Albedo

The broadband albedo of the sea is uncertain to ~0.005 (i.e, is it 0.070 or 0.065?). The latest time-mean TOA (top of the atmosphere) CERES albedo is more accurate than ~0.005 (when corrected for the effect of earth's annulus). Hence satellite-based estimates of the atmospheric absorption of broadband SW (i.e., Charlock and Alberta, 1996) and aerosol forcing are significantly limited by our ability to specify ocean surface albedo as a function of wind speed and other parameters.

2. A Year of Observations versus Theory

We compute ocean albedo with a coupled model (Jin and Stamnes, 1994), explicitly accounting for radiative processes in both sea and air, and using measured wind speeds and aerosol optical depth (AOD). Theory is compared with observations from the long-term CERES Ocean Validation Experiment (COVE) sea platform (25km east of Virginia Beach). In every season, observed albedoes are slightly higher than computed albedoes (Jin et al., 2001).

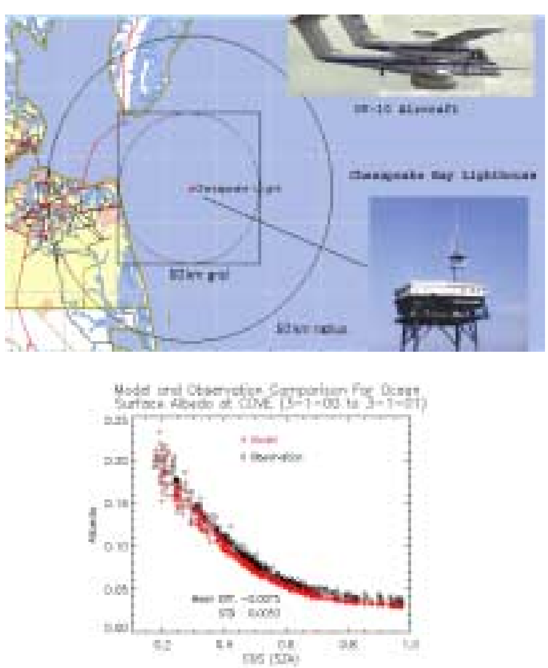

Figure 1 Broadband albedo of sea from coupled model and COVE observations. Cloud-free as per Long-Ackerman pyranometer time series. AERONET AOD.

3. Aircraft vs Sea Platform Observations

Are the observations of ocean albedo at the COVE platform representative of the nearby sea? What about the platform's shadow and its steel legs? We attempt to untie this knot with the Cheasapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) field campaign. CLAMS aims to tell us how well the point measurements at COVE represent the surrounding (~1km) sea.

Some comparisons with the OV-10 aircraft (~185m) on July 17, 2001 are not conclusive (aircraft data are green in Fig. 2). See adjacent posters by Zhang, Rutledge, and Smith for possible updates. Local noon is around 1709 GMT (UTC) - not ideal for a test of platform shading. Isolated clouds cause "fuzz" in the observations. COVE observed albedos still exceed the modeled values slightly. The discrepancies in upwelling (Fig. 2, top left panel) flux may be within the margin of error for the COVE platform measurements, which subscribed to the rigorous WCRP BSRN protocol.

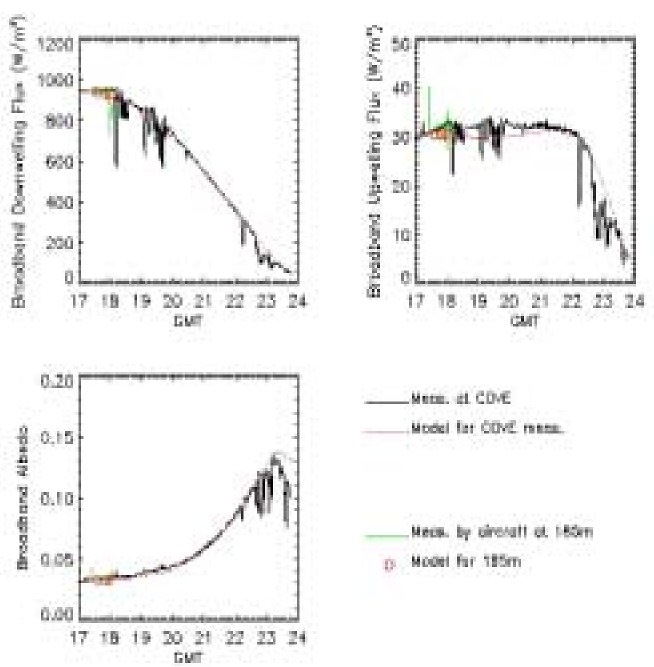

Figure 2 COVE platform measurements (solid black), aircraft measurements at 185m (green), and coupled model at sea level (red dash) and at 185m (red circle) for July 17, 2000. All quantities broadband.

CLAMS Aircraft Campaign, and CERES on Terra Atmosphere in Cloud-free Conditions

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4. Sea Absorption and Spectral Albedo

The coupled model in Fig. 1 uses chlorophyll (Chl) measured at the mouth of the Chesapeake Bay (19km from COVE) and sea absorption from Gordon and Morel (1983) and Morel (1991). Inserting more Chl in the model (Fig. 2) as per Chl observations at COVE itself (Fig. 3, right) increases the broadband albedo marginally, but not nearly enough to match observations.

During CLAMS, Prof. Glen Cota (Old Dominion University cota@ccpo.odu.edu) also measured sea absorption in situ at COVE (Fig. 3, left). We insert the measured absorption and Chl into the coupled model. Then we compare (Figure 4) with the modeled spectral albedo using the Gordon-Morel parameterization as above; and also with MSFSR spectral albedo observations at COVE. At the shorter wavelengths (415nm and 496nm on top panels of Fig. 4), the albedo modeled using the observed sea absorption falls, and it compares well with the spectral observations. There is hardly any effect at the longer wavelegnths (lower panels of Fig. 4).

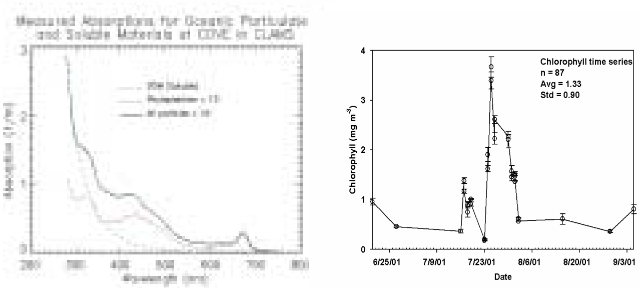

Figure 3 Sea optics measured by ODU (Cota). Left: absorption (1/m). Right: Chl (mg m-3)

5. Conclusions and Discussion

Careful coastal observations of broadband sea albedo slightly exceed values using a sophisticated coupled model. When in situ absorption measurements drive the model, spectral albedo below 500nm decreases and agrees with observations; but the broadband is then a little worse. Such discrepancies contribute significantly to errors in aerosol forcing, which must be retreived with high accuracy for climate assessments. There are corresponding problems for the sun glint region (see poster by W. Su).

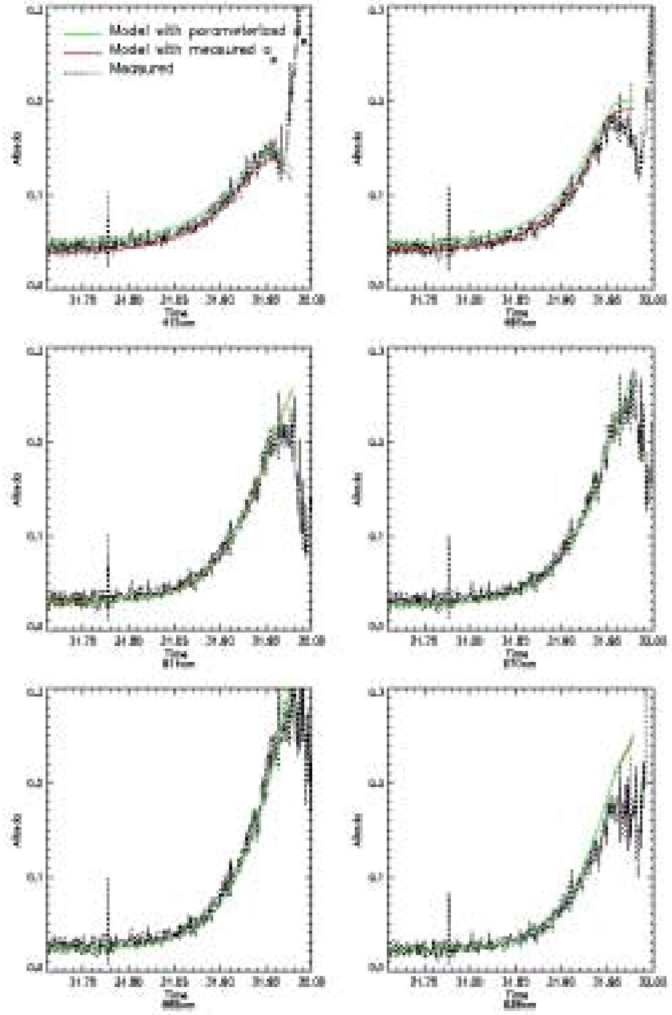

Figure 4. COVE spectral albedo (July 31, 2001). MFRSR measurements (black); coupled model with parameterized (green) and measured (red) sea absorption.

6. References

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